FEEDING HABITS AND ESTIMATION OF DAILY RATION OF POOR COD *TRISOPTERUS MINUTUS CAPELANUS* (GADIDAE) IN THE ADRIATIC SEA

by

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ABSTRACT. - The feeding habits of poor cod *Trisopterus minutus capelanus* (Risso) in the Adriatic Sea were studied with 24-h sampling cycles in October 1985 and April and July 1986. In data analysis, fish were grouped into two size classes: juveniles (immature yearling specimens) and adults. For both classes food composition was based on few target items which varied with season and fish size. Small poor cod fed essentially on Mysidacea (*Erythrops* spp.) and small Decapoda Natantia (*Processa nouveli, Philocheras bispinosus*) all the year round while larger specimens fed on larger organisms (*Alpheus glaber, Liocarcinus* spp. and teleosts). The analysis of stomach fullness in the 24 hours showed that *T. m. capelanus* is a continuous feeder, also if some periodicity can be detected, probably linked to different avaliability of the prey, due to their diel behaviour pattern. The exponential model of Elliott and Persson (1978) was used to calculate the daily ration in the field. Estimates ranged from 4.30 to 4.95% of wet body weight for juveniles and from 4.53 to 5.45% of wet body weight for adults. These values are higher than those reported for congeneric species in the North Atlantic, possibly due to the higher temperature of the Adriatic Sea.

RÉSUMÉ. - Habitudes alimentaires et estimation de la ration journalière de *Trisopterus minutus capelanus* (Gadidae) dans l'Adriatique.

Des cycles d'échantillonnage de 24 h, effectués en octobre 1985 et en avril et juillet 1986, ont permis d'étudier les habitudes alimentaires du capelan *Trisopterus minutus capelanus* (Risso) dans l'Adriatique. Les individus ont été regroupés dans deux classes: jeunes (âgés de moins d'un an) et adultes. Bien que l'alimentation repose sur peu d'éléments cibles pour les deux classes, les juvéniles de *T. m. capelanus* se nourrissent notamment de Mysidacea (*Erythrops* spp.) et de petits Decapoda Natantia (*Processa nouveli* et *Philocheras bispinosus*) pendant toute l'année, alors que les adultes se nourrissent d'organismes plus volumineux (*Alpheus glaber, Liocarcinus* spp. et téléostéens). L'analyse du remplissage de l'estomac pendant les périodes de 24 h montre que *T. m. capelanus* se nourrit pendant toute la journée, même si une périodicité de l'alimentation peut être envisagée en relation avec la différente vulnérabilité de certaines proies au cours de la journée. Le modèle exponentiel d'Elliott et Persson (1978) a été utilisé pour calculer la ration journalière. Les estimations s'échelonnent de 4,30 à 4,95% du poids humide pour les jeunes, et de 4,53 à 5,45% du poids humide pour les adultes. Ces valeurs sont supérieures à celles qui ont eté obtenues pour des espèces congénères dans l'Atlantique du Nord, en raison sans doute de la température plus élevée de l'Adriatique.

Key-words. - Gadidae, *Trisopterus minutus capelanus*, MED, Adriatic Sea, Feeding, Daily ration.

The poor cod *Trisopterus minutus capelanus* (Risso) is among the most abundant gadoid fish in the central Adriatic Sea. Here it is actively exploited by bottom trawlers

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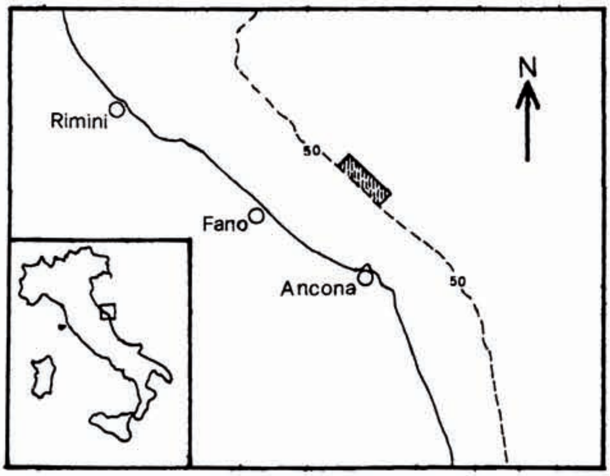

Fig. 1. - Sampling area off Ancona (Central Adriatic Sea).

on muddy or sandy-muddy bottoms at depths ranging from 40 to 250 m, accounting for more than 7% of total annual landings of bottom trawl fishery (Cingolani *et al.*, 1986).

The biology of *T. m. capelanus* has been investigated in the Adriatic within the framework of I.R.PE.M. (Istituto Ricerche Pesca Marittima, Ancona) studies on the most important species occurring on the Adriatic trawling grounds (Froglia, 1981; Froglia and Gramitto, 1982; Giannetti and Gramitto, 1993). Its feeding habits and a field evaluation of its daily ration are herein discussed.

Feeding of *T. minutus* and congeneric species (*T. esmarkii* and *T. luscus*) has been studied in the north-east Atlantic and North Sea (Labarta, 1976; Armstrong, 1982; Dauvin, 1988; Mattson, 1990). In the Mediterranean, data come from Planas and Vives (1952) for Spain, Politou *et al.* (1989) and Politou and Papaconstantinou (1994) for Greece and from Biagi *et al.* (1992) for the Tyrrhenian Sea.

MATERIAL AND METHODS

Sampling operations were carried out on a "Nephrops ground" 15 miles NNW off Ancona (depth 52-54 m) (Fig. 1) by R/V "S. Lo Bianco", using an Italian bottom trawl with a 32-mm (stretched) cod end mesh.

Samples were collected in October 1985 and April and July 1986. Sampling tows (7 in October and 8 in April and July) of one hour were performed during a 24-h period at 3-h intervals. Water temperature (T, °C) near the bottom was measured for each sampling cycle using Richter and Wiese reversing thermometers.

For each haul, poor cod were weighed (total weight) and measured to the cm below. Fish of a subsample were injected in the abdominal cavity with 5% formol saline solution to interrupt the digestive process and preserved in the same solution. In the laboratory, specimens exhibiting everted stomach or signs of regurgitation (food in the mouth or empty but thin-walled stomachs) were discarded. The others were assigned to 1-cm length classes and a subsample of about 50 individuals (representative of the length frequency

distribution in the catch) was formed randomly. Owing to their low number, all specimens ≥ 18 cm total length (TL) were examined.

In the Mediterranean, *T. m. capelanus* reaches sexual maturity at the end of the first year of life, at about 13 cm TL; ripe females are found from January to early May and juveniles first appear in the April catches (Vives and Suau, 1956; Froglia and Zoppini, 1981; Biagi *et al.*, 1992). Two age-related groups, juveniles (youngs of the year) and adults, were formed based on specimen size and on the von Bertalanffy growth curve obtained for this species in the central Adriatic by Giannetti and Gramitto (1993).

Every stomach was weighed (wet weight), before and after removing its content, on an analytical scale with an accuracy of 10^{-4} g. Food items were identified to the lowest possible taxonomic category and counted. All prey of the same taxon found in specimens of the same size group were then pooled and weighed (wet weight) with an accuracy of 10^{-4} g.

The stomach repletion (SR) was estimated on the basis of the apparent state of fullness using a four-points scale (Gramitto, 1985). SR1: very thick walls, empty stomach; SR2: thick walls, small quantity of food; SR3: thin walls, medium quantity of food; SR4: very thin and stretched walls, full stomach.

Due to the low number of specimens in some age classes, the percent frequency of the four SR degrees in the 24-h cycle could be calculated only for the juveniles of the October sample (n = 365) and the adults collected in April (n = 397) and July (n = 273).

Stomach content analysis was performed using some common indices (Hyslop, 1980): Vacuity index (V%), Frequency of occurrence (F%), Weight (W%), Mean number of each item (N), and Alimentary coefficient Q (Hureau, 1970) which takes in account also prey weight. A mean weight index (WI_x) computed for each haul in every 24-h cycle was used to describe the feeding rhythm on the most important prey:

$$WI_x = \frac{\text{total weight of prey}}{\text{total number of stomachs}}$$

The exponential model of Elliott and Persson (1978) was used to calculate food intake over a time interval (C_t):

$$C_t = \frac{Rt\left(S_t - S_0 e^{-Rt}\right)}{\left(1 - e^{-Rt}\right)}$$

where S_0 and S_t are the stomach content weights at the beginning and at the end of the time interval t (in this study t = 3 h) and R is the instantaneous coefficient of gastric evacuation.

The daily ration (DR) was obtained by summing all the non-negative values of C_t in the 24-h cycle. The standard error was approximated following the method of Worobec (1984). Both DR and C_t were expressed as percentage of body weight (% BW).

The Elliott and Persson model assumes a constant rate of feeding over the time interval t, but the estimates of C_t are not affected by discontinuous feeding if the stomach samples are collected at intervals of 3 h or less (Elliott and Persson, 1978; Cortes, 1997).

The instantaneous coefficient of gastric evacuation (R) is mostly influenced by food type and increases with increasing temperature (Durbin *et al.*, 1983). Worobec (1984) calculated the relationship between R and T from experimental data on fish feeding on small organisms (polychaetes, small crustaceans).

Her equation (R = 0.0175 T - 0.0442 with r^2=0.62 and d.f. = 34) was used to calculate the values of R in the present study.

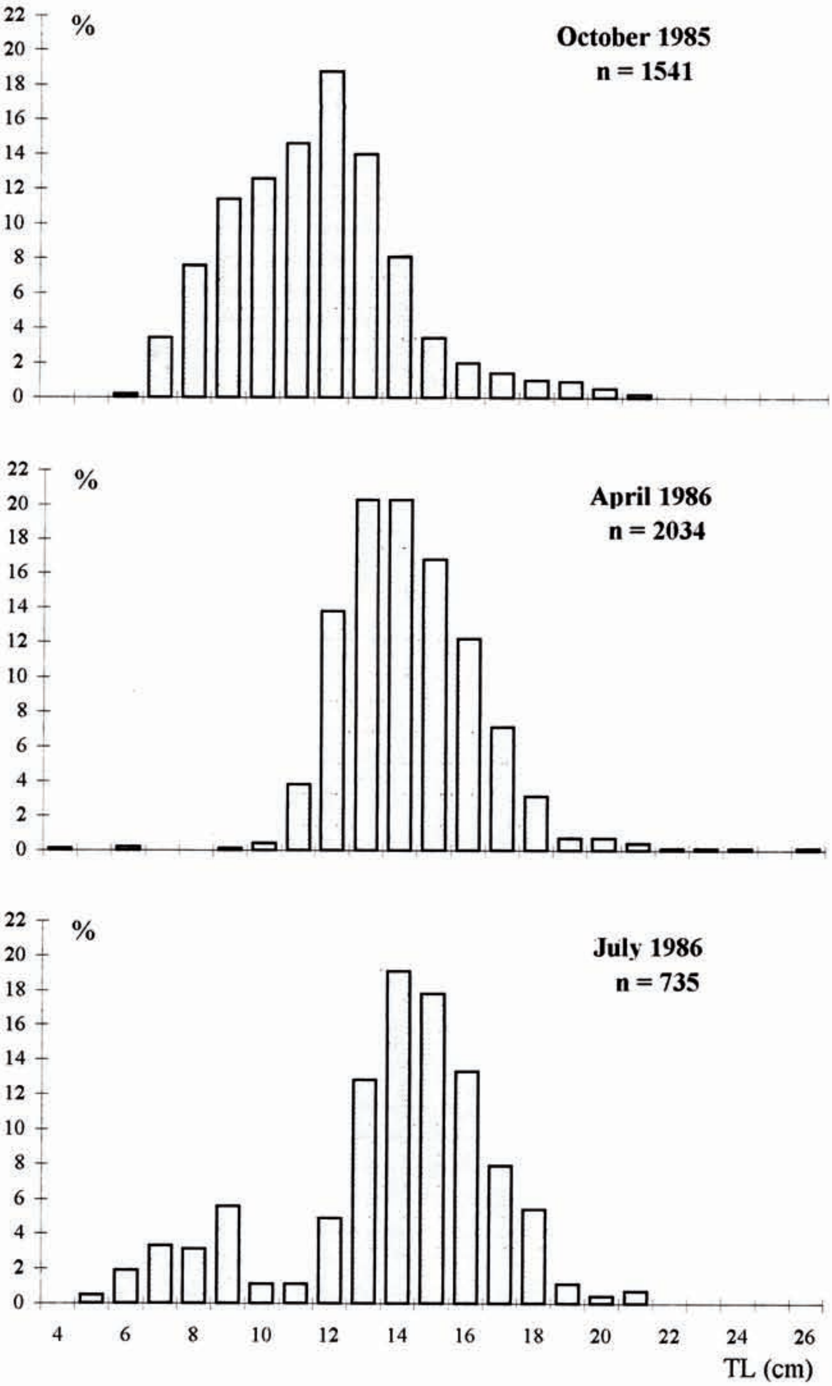

Fig. 2. - Size frequency distributions of *Trisopterus minutus capelanus* in the sampled months.

RESULTS

The length frequency distributions of the samples (Fig. 2) were in line with the existing data on the structure of the poor cod population in the Adriatic (Paolini *et al.*, 1994).

Of 4310 specimens, 1186 - ranging in size from 4 to 21 cm - were subjected to stomach content analysis (Table I). As only three juveniles were caught in April, they were not utilized in further computations.

In spring (Table II), *Processa nouveli* (F% = 68.7%, Q = 857) and *Alpheus glaber* (F% = 40.6, Q = 216) were preferential prey for adult specimens and formed the bulk of food. In summer (Table III), adult *T. m. capelanus* fed as in spring, and juveniles preyed essentially on Mysidacea. *Erythrops* spp. exhibited a high frequency of occurrence (F% = 78.1), with a mean number of 26.6 individuals per stomach. In autumn (Table IV), juveniles and adults fed on the same items (*P. nouveli* and *P. bispinosus*). *Erythrops* spp. and *A. glaber* became secondary food items for juveniles and adults respectively.

Fish prey were found in all seasons, more often in the stomachs of adults and mostly represented by Gobiidae (*Gobius niger* and *Lesueurigobius friesii*), *Callionymus maculatus* and *Antonogadus megalokynodon*. *Cepola rubescens* and *Buglossidium luteum* were found only once. Remains of *T. m. capelanus* were identified in three stomachs.

Considering all non-empty stomachs independently of sampling season (Fig. 3), the importance of Mysidacea decreased both in frequency and mean number per stomach, as predator size increased. A similar trend was evident for *P. bispinosus*, which was replaced by *A. glaber* as preferential prey of the bigger fish. The frequency of larger prey types (*A. glaber* and teleosts) increased remarkably as predators grew larger, while the mean number of prey per stomach remained almost constant for teleosts and increased for *A. glaber*.

The Vacuity index did not differ significantly among seasons (Table I). Its low value (always less than 8%) agreed with the existence, in the three seasons sampled, of a considerable proportion of filled stomachs (SR3 + SR4) all day round (Fig. 4). Never-

Table I. - Number of specimens of *Trisopterus minutus capelanus* caught (A) and examined (B) for stomach contents in each 24-h sampling cycle (number of empty stomachs in brackets). The vacuity index (V%) was calculated on examined specimens.

	October 1985		April 1986		July 1986	
Time at haul start	**A**	**B**	**A**	**B**	**A**	**B**
15h00	294	110 (13)	322	46 (5)	143	51 (7)
18h00	190	34 (1)	371	50 (8)	88	46 (5)
21h00	165	46 (1)	133	53 (1)	90	44 (7)
24h00	221	98 (5)	183	50 (3)	44	41 (1)
3h00	135	52 (2)	196	46 (1)	56	40 (0)
6h00	251	49 (0)	238	53 (0)	81	43 (1)
9h00	285	53 (1)	283	49 (0)	141	39 (1)
12h00	---	--- --	308	53 (2)	92	40 (5)
Total number	1541	442 (23)	2034	400 (20)	735	344 (27)
V%		5.2		5.0		7.9

theless, an increase in feeding activity, highlighted by an increase in the number of full stomachs (SR4), could be detected and correlated with the mean weight of main prey for juveniles and adults (Fig. 5). Juveniles had the highest percentages of full stomachs around sunset and sunrise (Fig. 4), corresponding to predation on Mysidacea and on *P. bispinosus* and *P. nouveli*, respectively (Fig. 5).

Adults exhibited only one maximum in stomach fullness, around sunrise (Fig. 4), corresponding to predation on *P. nouveli* and *A. glaber* (Fig. 5).

The results of food consumption calculations are listed in tables V, VI, and VII.

Estimates of daily ration ranged from 4.53 to 5.45% of wet body weight for adults, and from 4.30 to 4.95% of wet body weight for juveniles, with the highest values in July and October, respectively.

Table II. - Mean number per stomach (N), frequency of occurrence (F%), percent weight (W%) and alimentary coefficient (Q) of prey identified in the stomachs of *Trisopterus minutus capelanus* in April 1986 (number of empty stomachs in brackets). N.E.I.: Not Either Identified; + : present, not counted items.

	TL ≥ 9 cm			
Number of stomachs	397 (20)			
Prey taxa	N	F%	W%	Q
Polychaeta	+	18.0	1.7	5
Bivalvia	---	---	---	---
Gasteropoda	1.3	1.9	0.2	< 1
Cephalopoda	1.0	1.1	0.7	< 1
Isopoda	1.0	0.3	< 0.1	< 1
Amphipoda	1.9	46.1	1.3	21
Erythropinae	2.0	22.8	0.1	1
Mysidacea	1.4	19.1	0.3	1
Processa nouveli	2.3	68.7	31.0	857
Philocheras bispinosus	2.0	52.2	3.1	58
Alpheus glaber	1.2	40.6	24.4	216
Solenocera membranacea	1.0	0.8	0.1	< 1
Natantia N.E.I.	+	3.7	0.3	< 1
Jaxea nocturna	1.2	1.3	0.4	< 1
Upogebia spp.	1.0	0.3	0.1	< 1
Callianassa spp.	1.0	0.3	0.1	< 1
Nephrops norvegicus	1.0	0.5	< 0.1	< 1
Galathea spp.	1.0	0.5	< 0.1	< 1
Anapagurus spp.	1.0	6.4	0.3	< 1
Liocarcinus spp.	1.1	13.8	8.4	23
Goneplax rhomboides	1.1	1.9	0.4	< 1
Brachyura N.E.I.	+	7.7	1.5	2
Decapoda N.E.I.	+	4.5	0.5	< 1
Crustacea N.E.I.	+	6.1	0.4	< 1
Pisces	1.1	23.3	23.9	104
Unidentified items	+	2.4	0.6	---

DISCUSSION

Trisopterus m. capelanus in the Adriatic feeds on few, benthic target items: Crustacea (Peracarida, Decapoda Natantia and Brachyura) and teleosts. All other prey (e.g., Decapoda Macrura and Anomura, Polychaeta, Cephalopoda) are accidental food items. The finding of eggs and pleopods and occasional fragments of legs of large Decapods, or bites of fish meat together with detritus suggest that poor cod feeds also on dead organisms found on the bottom, possibly trawler discards. The sporadic finding of remains of *T. m. capelanus* may be either the result of this behaviour or cannibalism.

Qualitative food composition agrees with the data obtained for other Mediterranean areas (Planas and Vives, 1952; Biagi, 1992; Poulitou and Papaconstantinou, 1994)

Table III. - Mean number per stomach (N), frequency of occurrence (F%), percent weight (W%) and alimentary coefficient (Q) of prey identified in the stomachs of *Trisopterus minutus capelanus* in July 1986 (number of empty stomachs in brackets). N.E.I.: Not Either Identified; + : present, not counted items.

	TL ≤ 11 cm				TL > 11 cm			
Number of stomachs	71 (7)				273 (20)			
Prey taxa	**N**	**F%**	**W%**	**Q**	**N**	**F%**	**W%**	**Q**
Polychaeta	+	6.2	2.0	< 1	+	14.2	0.9	1
Bivalvia	---	---	---	---	1.0	1.2	< 0.1	< 1
Gasteropoda	1.0	3.1	0.2	< 1	1.0	1.6	< 0.1	< 1
Cephalopoda	---	---	---	---	1.0	7.1	4.0	3
Isopoda	---	---	---	---	1.0	0.4	< 0.1	< 1
Caprellidae	---	---	---	---	1.2	2.0	< 0.1	< 1
Amphipoda cetera	1.9	46.9	13.7	51	1.6	28.8	0.6	3
Erythropinae	26.6	78.1	46.8	4017	6.2	48.2	0.6	23
Mysidacea cetera	1.4	45.3	4.1	11	1.6	26.1	0.3	2
Processa nouveli	1.7	18.7	6.4	9	3.4	53.4	12.4	272
Philocheras bispinosus	2.2	46.9	11.0	48	2.1	44.7	2.9	34
Alpheus glaber	1.0	1.6	0.5	< 1	1.3	53.7	49.7	425
Solenocera membranacea	---	---	---	---	1.0	0.4	< 0.1	< 1
Chlorotocus crassicornis	1.0	1.6	0.1	< 1	---	---	---	---
Natantia N.E.I.	+	1.6	0.2	< 1	+	2.4	0.2	< 1
Jaxea nocturna	---	---	---	---	1.1	5.1	3.5	2
Nephrops norvegicus	---	---	---	---	1.0	0.8	0.1	< 1
Anapagurus spp.	1.0	3.1	1.8	< 1	1.2	2.4	0.2	< 1
Liocarcinus spp.	1.0	1.6	1.1	< 1	1.3	17.8	9.4	26
Goneplax rhomboides	---	---	---	---	1.0	3.6	1.8	1
Brachyura N.E.I.	+	3.1	4.9	1	+	4.3	2.0	1
Decapoda N.E.I.	+	1.6	0.4	< 1	+	5.5	0.7	< 1
Crustacea N.E.I.	+	26.6	6.5	7	+	2.8	0.1	< 1
Pisces	1.0	1.6	0.2	< 1	1.0	9.1	10.3	11
Unidentified items	---	---	---	---	+	2.0	0.1	---

and is similar to that of congeneric species studied in the North Sea and Eastern Atlantic (Labarta, 1976; Armstrong, 1982; Lopez-Jamar *et al.*, 1984; Dauvin, 1988). Some differences in the diet can be explained by the relative abundance of certain prey types in the sampled areas. For instance Euphausiacea, which are preferential prey for the young specimens of the nominal species (Labarta, 1976; Armstrong, 1982), were not found in the stomachs of *T. m. capelanus* collected on the continental shelf of the central Adriatic where they were replaced by Crustacea Peracarida (Mysidacea and Amphipoda).

The preference for bigger prey types as predator size increases (Daan, 1973; Hespenheide, 1976; Macpherson, 1978), in this species results in the replacement of some small food organisms (*P. bispinosus*, Mysidacea and Amphipoda) by others of bigger size (*A. glaber*, *Liocarcinus* spp., teleosts).

Table IV. - Mean number per stomach (N), frequency of occurrence (F%), percent weight (W%) and alimentary coefficient (Q) of prey identified in the stomachs of *Trisopterus minutus capelanus* in October 1985 (number of empty stomachs in brackets). N.E.I.: Not Either Identified; + : present, not counted items.

	TL ≤ 13 cm				TL > 13 cm			
Number of stomachs	365 (21)				77 (2)			
Prey taxa	N	F%	W%	Q	N	F%	W%	Q
Polychaeta	+	5.2	0.4	< 1	+	16.0	0.9	< 1
Bivalvia	1.2	9.0	0.1	< 1	1.4	13.3	0.1	< 1
Gasteropoda	1.0	1.7	< 0.1	< 1	1.3	8.0	0.3	< 1
Cephalopoda	1.0	0.6	0.7	< 1	1.0	2.7	< 0.1	< 1
Scaphopoda	1.0	0.6	< 0.1	< 1	—	—	—	—
Isopoda	1.0	0.6	< 0.1	< 1	1.0	2.7	< 0.1	< 1
Caprellidae	2.2	1.7	< 0.1	< 1	—	—	—	—
Amphipoda cetera	1.5	39.5	1.8	5	1.5	26.7	0.7	1
Erythropinae	10.6	68.9	3.9	138	2.8	30.7	0.2	1
Mysidacea cetera	7.3	54.1	4.1	79	2.9	21.3	0.3	1
Processa nouveli	3.2	51.4	26.3	207	6.1	77.3	36.2	960
Philocheras bispinosus	7.0	92.7	45.9	1433	10.6	89.3	24.4	1306
Alpheus glaber	1.0	9.9	10.1	5	1.3	41.3	19.9	58
Natantia N.E.I.	+	1.4	0.3	< 1	—	—	—	—
Jaxea nocturna	1.0	0.3	0.1	< 1	1.0	5.3	1.0	< 1
Upogebia spp.	—	—	—	—	1.0	4.0	2.3	< 1
Callianassa spp.	1.0	0.3	0.1	< 1	—	—	—	—
Galathea spp.	1.0	0.3	0.1	< 1	—	—	—	—
Anapagurus spp.	1.0	0.6	0.1	< 1	—	—	—	—
Liocarcinus spp.	1.0	2.0	0.3	< 1	1.0	2.7	1.3	< 1
Goneplax rhomboides	—	—	—	—	1.0	2.7	0.4	< 1
Brachyura N.E.I.	—	—	—	—	+	2.7	0.5	< 1
Decapoda N.E.I.	+	1.4	0.1	< 1	+	2.7	0.3	< 1
Crustacea N.E.I.	+	28.5	3.0	2	+	18.7	1.4	2
Pisces	1.0	2.9	2.5	9	1.3	13.3	9.8	9
Unidentified items	+	0.3	< 0.1	—	—	—	—	—

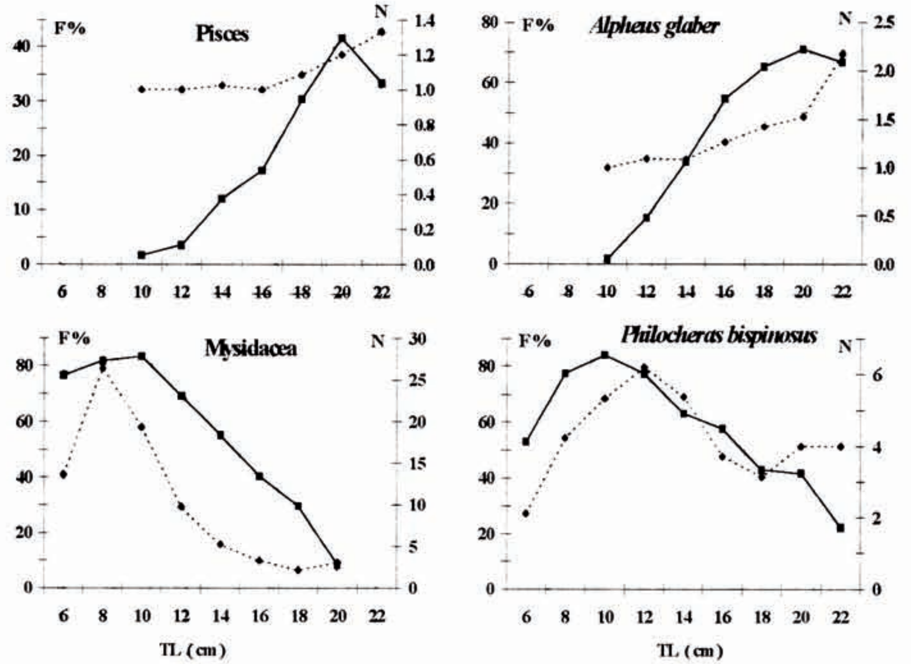

Fig. 3. - Trends of frequency of occurrence (F%, —■—) and mean number per stomach (N, --◊--) of some target preys of *Trisopterus minutus capelanus* with increasing predator size.

Armstrong (1982) reported a gradual increase of *Nephrops norvegicus* of the 0^+ age class in the stomach contents with increasing predator size. This does not seem to apply to Adriatic poor cod. In the present sample, small Norway lobsters were found in the stomachs of large *T. m. capelanus* only four times, even though the fish feeds intensively on other burrowing decapods of similar size living on "Nephrops grounds", such as *A. glaber*. This fact is not connected with the density of the *Nephrops* stock; indeed, the feeding habits of *T. m. capelanus* on another Adriatic "Nephrops ground", where population density is higher, were similar (Gramitto, unpubl. data). The most plausible explanation for the presence of *A. glaber* and the absence of *N. norvegicus* in stomach contents may be found in the behaviour of both predator and prey. The mouth of poor cod is designed for quick suction, i.e., quick capture of preys above the bottom (Mattson, 1990). During the night, *A. glaber* are more vulnerable to the net, because out of their burrows (Froglia and Gramitto, 1995). This behaviour makes this species an easier prey than young *Nephrops*, which in that relevant size range live - and feed - most of the time within burrows (Crnkovic, 1968; Chapman, 1980).

The low values of the vacuity index and the finding of filled stomachs all day round suggest that *T. m. capelanus* is a continuous feeder, as hypothesised by Biagi *et al.* (1992) for the Tyrrhenian Sea. The maxima observed in stomach fullness can be linked to an increased availability of some preys in particular periods of the day, due to their diel behaviour pattern (Mergardt and Temming, 1997).

Considering the large standard errors of the estimates of daily ration (DR), the consumption per day does not seem to vary with age or season. But the standard error associated with the DR is the sum of the standard errors of each food intake (C_t) estimate,

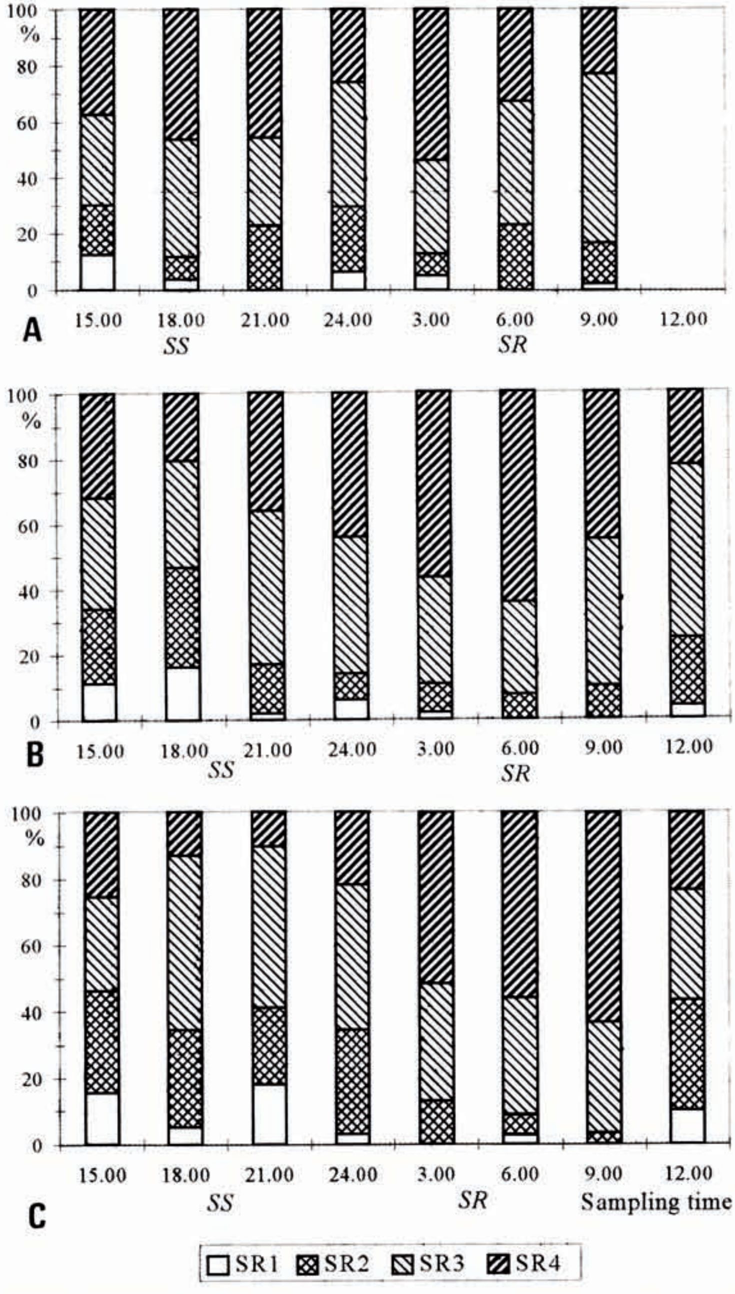

Fig. 4. - Stomach repletion (SR) of *Trisopterus minutus capelanus* in October juveniles (A), April adults (B) and July adults (C) (*SS* = sunset; *SR* = sunrise).

which is a function of the standard errors of the variables used in the Elliott and Persson model (Worobec, 1984). In the present study, the evacuation rate (R) is considered cons-

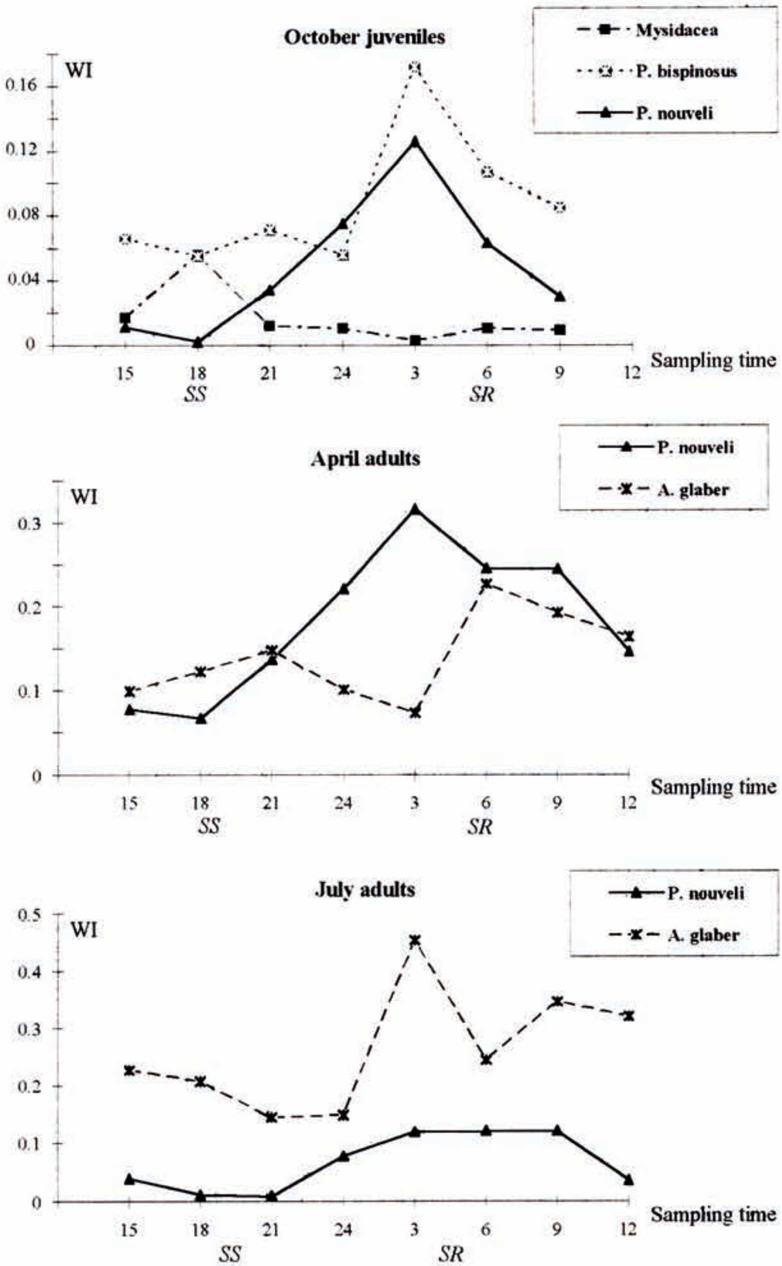

Fig. 5. - Mean weight index (WI) of main prey of *Trisopterus minutus capelanus* in October juveniles and April and July adults (*SS* = sunset; *SR* = sunrise).

tant and the stomach contents weights (S_0 and S_t) are thus the only variables. As several authors have noted (e.g., Hyslop, 1980), when weighing prey items variation in the

amount of water is one of the main sources of error. The use of wet weight as a unit of measurement of stomach content can be one of the causes of the high standard error associated with these parameters, and consequently with daily rations, as suggested also by Macpherson (1985).

In computing the DR, negative consumption values were excluded since it is impossible to evacuate from the stomach more than is ingested (Worobec, 1984). These values can occur if the amount of food in the stomach between two subsequent samples is lower than predicted R used (Durbin *et al.*, 1983). This can be due to the difficulty in finding estimates of R which adequately fit the prey eaten. In the present study, differences in food type were not considered, based on the assumption that "small crustaceans" could be taken to include Mysidacea as well as *P. nouveli* and *A. glaber*. This may have produced the differences in DR between juveniles and adults observed in the July sample, when their feeding habits are quite different. In October, when both feed on the same prey items, their daily ration values are quite similar (4.95 and 5.02% BW, respectively). These results suggest that Mysidacea and Decapoda Natantia in fact require different digestion times, but for lack of laboratory facilities (aquaria), experiments to adapt the R estimates to these results could not be performed.

The DR values obtained in the present study are higher than those reported for congeneric species (Armstrong, 1982) and other gadoids (Durbin *et al.*, 1983) in the North Atlantic. Also the growth both in length and in weight (Giannetti and Gramitto, 1993) is faster if compared with that of the nominal species in the Plymouth area (Menon, 1950). The higher bottom temperatures are likely to be the main cause of the greater food intake and faster growth of *T. m. capelanus* in the Adriatic Sea.

Table V. - Number of fish examined, mean stomach content weight (± standard error), consumption and daily ration (± standard error) of *Trisopterus minutus capelanus* sampled in spring. All weights are expressed as percentage of body weight (% BW).

17-18 April 1986	Time at haul start	N. fishes	Mean st. weight (% BW)	Consumption (% BW)	Daily ration (± s.e.)
TL ≥ 9 cm	15h00	44	1.36 (± 0.32)		4.53 (± 5.56)
				-0.28	
Temp. = 9.4 °C	18h00	49	0.71 (± 0.11)		
(SS)				1.12	
R = 0.1203	21h00	53	1.43 (± 0.14)		
				0.53	
	24h00	50	1.44 (± 0.17)		
				1.05	
	03h00	46	1.89 (± 0.24)		
				0.76	
(SR)	06h00	53	1.96 (± 0.20)		
				0.42	
	09h00	49	1.72 (± 0.18)		
				-0.03	
	12h00	53	1.17 (± 0.13)		
				0.65	

In gadoid fishes, there is a linear correlation between daily ration and daily weight increment (Jones and Hislop, 1972). A good correlation between these two parameters is thus presumable in the Adriatic Sea and, as a consequence, also a high conversion efficiency of food into growth.

Table VI. - Number of fish examined, mean stomach content weight (± standard error), consumption and daily ration (± standard error) of *Trisopterus minutus capelanus* sampled in summer. All weights are expressed as percentage of body weight (% BW).

3-4 July 1986	Time at haul start	N. fishes	Mean st. weight (% BW)	Consumption (% BW)	Daily ration (± s.e.)
TL ≤ 11 cm	15h00	12	0.85 (± 0.23)		4.30 (±4.05)
				-0.41	
Temp. = 11.9 °C	18h00	8	0.20 (± 0.10)		
(SS)				1.48	
R = 0.1641	21h00	5	1.29 (± 0.70)		
				-0.03	
	24h00	9	0.76 (± 0.25)		
				0.89	
	03h00	9	1.17 (± 0.22)		
(SR)				0.30	
	06h00	9	0.95 (± 0.25)		
				0.98	
	09h00	9	1.36 (± 0.31)		
				0.54	
	12h00	10	1.26 (± 0.43)		
				0.11	
TL > 11 cm	15h00	39	1.09 (± 0.25)		5.45 (± 5.43)
				0.30	
	18h00	38	0.90 (± 0.14)		
(SS)				0.15	
	21h00	39	0.67 (± 0.11)		
				0.82	
	24h00	32	1.05 (± 0.22)		
				1.78	
	03h00	31	2.05 (± 0.28)		
(SR)				0.87	
	06h00	34	1.94 (± 0.21)		
				1.09	
	09h00	30	2.04 (± 0.28)		
				0.06	
	12h00	30	1.30 (± 0.23)		
				0.38	

Table VII. - Number of fish examined, mean stomach content weight (± standard error), consumption and daily ration (± standard error) for *Trisopterus minutus capelanus* sampled in autumn. All weights are expressed as percentage of body weight (% BW).

9-10 October 1985	Time at haul start	N. fishes	Mean st. weight (% BW)	Consumption (% BW)	Daily ration (± s.e.)
TL ≤ 13 cm	15h00	96	1.05 (± 0.11)		4.95 (± 4.09)
				0.83	
Temp. = 12.5°C (SS)	18h00	26	1.27 (± 0.21)		
				0.43	
R = 0.1745	21h00	35	1.09 (± 0.15)		
				0.66	
	24h00	78	1.16 (± 0.13)		
				1.22	
	03h00	39	1.64 (± 0.18)		
				0.36	
(SR)	06h00	43	1.25 (± 0.15)		
				0.31	
	09h00	48	0.98 (± 0.08)		
				1.14	
TL > 13 cm	15h00	14	0.58 (± 0.10)		5.02 (± 2.85)
				0.31	
(SS)	18h00	8	0.59 (± 0.21)		
				0.60	
	21h00	11	0.82 (± 0.19)		
				1.27	
	24h00	20	1.47 (± 0.24)		
				1.27	
	03h00	13	1.86 (± 0.21)		
				1.21	
(SR)	06h00	6	2.04 (± 0.32)		
				0.20	
	09h00	5	1.37 (± 0.29)		
				0.16	

Acknowledgements. - I am grateful to my colleagues Drs. C. Froglia and M. La Mesa for their critical review of the manuscript and Dr. E. Arneri for useful discussions throughout the study. I also wish to thank an anonymous referee for suggestions and comments, and Dr. S. Modena for English reviewing.

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Reçu le 27.03.1998.
Accepté pour publication le 06.01.1999.